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Control of the Rosy Apple Aphid in Ohio

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INTRODUCTION

An important pest of apple trees is the rosy apple aphid, *Dysaphis plantaginea* (Passerini). Although it is generally present in orchards in the spring and fall, feeding by the aphids on the young, developing fruit can cause severe dwarfing and malformation of the apples. Extensive leaf curling and production of honey dew, on which a sooty fungus grows, can also result.

Control of this pest can be obtained by insecticide sprays in the spring. Except for a report by Rammer *et al.* (11), the most recent papers on insecticidal control of the rosy apple aphid have been published in the 1950's (1, 2, 8, 9). Since that period, a number of new insecticides have been introduced.

The objective of this research conducted at Wooster, Ohio, from 1964 through 1968 was to determine the effectiveness and best time for application of newer insecticides in relation to some older standard materials.

MATERIALS AND METHODS

All tests were set up in randomized complete block designs with single-tree plots and with each block made up of a single variety of apple. The apple varieties, number of blocks per treatment, dates of treatment, and the fungicides tank-mixed with the insecticides are presented in the tables.

All insecticides were applied as dilute sprays to point of runoff with handguns and a hydraulic sprayer delivering 35 gallons per minute at 450-600 p.s.i. Although a full schedule of insecticide treatments was applied from the petal fall stage through August, only the dates of the first two post-bloom sprays are listed in the experiments in Table 2. These are the sprays which would most likely affect rosy apple aphid populations after bloom.

The treatments were evaluated by counting all leaf clusters showing aphid leaf-curling injury. These counts were made on June 10-16 from all lower parts of each tree up to a height of about 6-7 ft. In tests where a full schedule of insecticides was applied, 200-400 fruit per treatment were examined on Sept. 8-13 for malformed apples.

Each set of counts on aphid-injured leaf clusters per tree was analyzed with the analysis of variance procedure after transformation of the counts to logarithms. Duncan's multiple range test (3) was used to

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TABLE 1.—Control of Rosy Apple Aphid with Pre-bloom Treatments.

Treatment* and Timing	Lb. AI per 100 gal.†	No. of Aphid-injured Leaf Clusters per Tree‡ 1966	1967	1968
Half-inch green (April 10-21)				
Superior oil 70-sec. vis.	2 %	4.2cd	4.2ab	2.1bcd
Superior oil 70-sec. + benzene hexachloride 10-12 WP	2 % + 0.10-0.12	1.3de	0c	1.6bcd
Superior oil 70-sec. + carbophenothion 25 WP	2 % + 0.25	—	—	0.6bcd
Superior oil 70-sec. + ethion 0.15 lb.**	2 %	0.3e	0.7bc	—
Superior oil 70-sec. + Imidan 50 WP	2 % + 0.75	0.2e	—	—
Superior oil 70-sec. + Imidan 50 WP	2 % + 0.5	—	1.7bc	—
Superior oil 70-sec. + phosphamidon 8 EC	2 % + 0.25	0.7de	—	—
Tight cluster (April 16)				
Benzene hexachloride 12 WP	0.24	—	—	1.5bcd
Superior oil 70-sec. vis.	1.5 %	—	—	3.1abc
Pre-pink (April 19-28)				
Benzene hexachloride 10-12 WP	0.2-0.24	7.1bc	—	2.8abcd
Parathion 15 WP	0.15	2.3cde	—	—
Superior oil 70-sec. vis.	1.5 %	—	—	3.1abc
Pink (April 20-May 4)				
Azinphosmethyl 25 WP	0.31	1.2de	0.4bc	2.5bcd
Benzene hexachloride 10-12 WP	0.2-0.24	22.7ab	2.0bc	3.6ab
Demeton 2 EC	0.12	0.9de	0.4bc	—
Diazinon 50 WP	0.38	1.4de	1.2bc	0.2d
Dimethoate 2.67 EC	0.25	—	0.9bc	—
Dimethoate 2.67 EC	0.33	1.2de	—	—
Imidan 50 WP	0.5	—	1.3bc	2.5bcd
Malathion 25 WP	0.5	8.4bc	—	—
Malathion 25 WP	0.62	—	2.2bc	—
Oxydemetonmethyl 2 EC	0.25	—	0.3c	0.3cd
Parathion 15 WP	0.15	2.1cde	0.2c	—
Phosphamidon 8 EC	0.25	0.2e	0.2c	1.2bcd
Superior oil 70-sec. vis.	1.5 %	—	0.6bc	—
Fungicide check	—	62.4a	13.9a	10.9a

*Formulations of insecticides presented as percent WP or lb. active ingredient per gal. of EC. Each applied to four trees (two Cortland and two Rome). No fungicides added except for pink treatments in 1967 when insecticides were mixed with sulphur plus dodine.

†Superior oil presented as percent oil formulation in spray mixture.

‡Means in the same column flanked by the same lower case letter are not significantly different at the 5% level.

**A formulated mixture.

test for significance of the means at the 5% level. Data presented in the tables are based on the reconversion of the logarithms, after analysis, to number of aphid-injured leaf clusters per tree.

RESULTS AND DISCUSSION

Excellent control of the rosy apple aphid was provided by the use of superior oil plus an organophosphate insecticide in the half-inch green stage of apple bud development (Table 1). The addition of benzene hexachloride to superior oil also resulted in control which was significantly better than the check treatments, and was statistically equal to the oil plus organophosphate spray.

Use of superior oil alone at the half-inch green stage in 1966 was very effective against a very high aphid population. This result led to a further evaluation of oil in subsequent years. Although significantly better control was obtained in 1968, the difference between the oil and check counts in 1967 was nonsignificant. A comparison between an oil spray and one of the mixtures applied at half-inch green indicates that possibly better control can be achieved with an oil-organophosphate or oil-benzene hexachloride mixture.

Generally, excellent aphid control has been achieved with an oil-organophosphate spray (8, 9). Cutright (2) obtained excellent results with the addition of benzene hexachloride or an organophosphate to oil. The control afforded by oil alone at half-inch green was not satisfactory

Table 2.—Control of Rosy Apple Aphid with Post-bloom Treatments.

Treatment*	Lb. AI per 100 gal.	No. of Aphid-injured Leaf Clusters per Tree†		Percent of Apples Malformed by Aphid Feeding	
		1966	1967	1966	1967
Azinphosmethyl 25 WP	0.25	9.3b	1.9bc	3.0	0.3
Carbofuran 50 WP	0.50	5.3b	0.4c	1.0	1.7
Gardona 75 WP	0.75	16.3ab	—	2.0	—
Gardona 75 WP	0.54	—	5.3ab	—	5.3
Imidan 50 WP	0.5	11.2ab	1.4bc	3.0	2.0
Imidan 50 WP + carbophenothion 12.5 WP‡	0.5 + 0.12	7.9b	—	1.7	—
Phosalone 3 EC	0.5	—	0.6c	—	2.0
Fungicide check	—	58.2a	8.8a	5.7	6.2

*Formulations of insecticides presented as percent WP or lb. active ingredient per gal. of EC. Each mixed with captan and applied on May 17-23 at petal fall and again on May 31-June 1 at first cover to Golden Delicious, Jonathan, and Rome apple trees (three to four trees per treatment).

†Means in the same column flanked by the same lower case letter are not significantly different at the 5% level.

‡A formulated mixture.

in Cutright's tests, although he concluded that oil can give partial control of the rosy apple aphid. Gilgut *et al.* (5) and Hill and Bobb (7) have listed the application of superior oil alone as a satisfactory control measure for rosy apple aphid in southern New England and Virginia. The spray recommendations from Michigan (12) do not list superior oil for aphid control.

Based on the results presented in this paper, these data agree essentially with those by Gilgut *et al.* (5), who suggested the addition of an organophosphate to superior oil for better control of the rosy apple aphid. The addition of almost any organophosphate would probably enhance the efficacy of superior oil.

Excellent results have been obtained with combinations of oil plus carbophenothion, ethion, or malathion (2, 8, 9). The addition of an insecticide to the oil spray may be essential for more effective control of the newly hatched nymphs commonly present at the half-inch green stage. Hartzell and Strickland (6) concluded that "the rosy apple aphid usually begins to hatch when the fruit buds show green at the tips and may continue to emerge for nearly 2 weeks, the majority of the nymphs appearing within 1 week." The half-inch green sprays in the author's tests were made about 4-7 days after the average dates for the green-tip stage, which coincides with the timetable indicated by Hartzell and Strickland.

Treatments of oil were made at the pink stage in 1967 and at two different times in 1968 (Table 1). There was significant control with the pink application in 1967 compared to the check count, but the efficacy of a tight cluster or pre-pink oil spray in 1968 was not better. Although the rate of superior oil applied at a stage other than half-inch green was only 1.5%, control appeared to be about equal to that given by 2% at the half-inch green stage.

Benzene hexachloride gave variable control of the rosy apple aphid when applied at different times in the pre-bloom period (Table 1). Although the data indicate a progressively lesser degree of control as the apple buds are advanced in development, it would appear that benzene hexachloride generally does not offer a high degree of control unless it is added to an oil spray at half-inch green. Cutright (2) obtained similar results.

Parrott *et al.* (10) observed that, at the pink stage, many stem mothers were found on exposed parts of the leaves and unopened blossoms and relatively little leaf-curling had occurred. Garman (4) noted that curling frequently starts at about the bloom stage. Therefore, use of an insecticide at the pink stage is essentially aimed at the elimination of stem mothers and young nymphs.

Generally, all organophosphates applied at the pink stage of apple bud development gave significant control (Table 1). Control with organophosphates was usually better than that obtained with benzene hexachloride at this time. It also appears that the materials with systemic activity (*e.g.,* demeton, dimethoate, oxydemetonmethyl, and phosphamidon) may have been generally more effective than other insecticides. Control of rosy apple aphid with a spray in the pink stage was equivalent to that provided by an oil-insecticide mixture applied in the half-inch green stage.

Results from additional experiments during this period of time confirm the effectiveness of similar rates of demeton, dimethoate, and oxydemetonmethyl when applied in the pink stage to Cortland, Golden Delicious, Jonathan, and Stayman apple trees (check trees averaged 4.2 to 5.8 injured clusters and treated trees 0.0 to 0.7). In another test, Imidan [0, 0-dimethyl phosphorothioate S-ester with N-(mercaptomethyl) phthalimide] 50 WP (at a rate of 0.75 lb. AI) allowed only 0.2 aphid-injured clusters per tree in contrast to a check count of 20.1. Applications of acaricides such as dicofol, Galecron [N-(4-chloro-*o*-tolyl) - N, N-dimethylformamidine], and tetradifon at the pink stage did not control the rosy apple aphid in 1967 and 1968. Oxythioquinox was found to be significantly better than the check in 1964, but not in one test in 1966.

Table 2 shows the results on aphid control with insecticides applied at the petal fall and first cover stages. Phosalone and carbofuran showed excellent activity against the rosy apple aphid. Rammer *et al.* (11) also noted that carbofuran gave excellent control. Azinphosmethyl and Imidan did not seem to perform as well, and Gardona [2-chloro-1-(2, 4, 5-trichlorophenyl) vinyl dimethyl phosphate] did not provide significant control. Results of injured leaf clusters from an additional test in 1968 confirmed the ineffectiveness of Gardona 75 WP (0.54 lb. AI per 100 gallons) and indicated relatively poor control with carbofuran 75 WP (0.38 lb. AI).

The post-bloom period is not ordinarily thought of as a time in which to control rosy apple aphid. Curling of the leaves begins at about the bloom stage; however, Garman (4) and Parrott *et al.* (10) observed that aphids spread to new leaves and begin to cause more extensive curling at about the petal fall stage. Therefore, it seems that a petal fall spray, and possibly a first cover application, could aid greatly in reducing the number of aphids and subsequently the number of malformed fruit. It also appears that some treatments in the post-bloom period were successful in preventing extensive leaf curling, or at least curling was so minor that it may have been overlooked in sampling (Table 1).

Other workers have determined insecticide efficacy on the basis of the percentage of aphids killed after an insecticide was applied to curled leaves (1, 9, 11). Their results indicate excellent activity with demeton, diazinon, dimethoate, malathion, and parathion. Azinphosmethyl, endosulfan, and ethion were considered as noneffective or as giving erratic control. In exploratory research conducted on partially curled leaves in 1966, the author found more than 90% of the rosy apple aphids killed with sprays of azinphosmethyl, carbophenothion, and diazinon; Imidan and tepp were relatively less effective (50-70% kill). These results, combined with the data presented here, indicate that post-bloom applications of certain broad spectrum insecticides (*e.g.*, carbofuran and carbophenothion) could be very effective for control of the rosy apple aphid. Materials such as azinphosmethyl and Imidan cannot be depended upon to provide satisfactory control, but they could be considered as a supplemental control measure to add to the efficacy given by a pre-bloom aphid treatment.

There were signs of phytotoxicity in only two experiments. Some slight interveinal browning was recorded on 5-20% of Cortland apple leaves after the use of parathion in the pre-pink stage (Expt. 1966, Table 1). In Experiment 1967 (Table 1), the half-inch green oil treatments were made on April 10, and the temperature dropped to 25° F. that night and to 20° F. on the following night. As a result, there was edge and tip burning to 30-50% of the leaves and buds of Rome and Cortland trees sprayed with superior oil and with oil plus benzene hexachloride. The same injury occurred on 10-30% of the leaves and buds on trees treated with oil plus Imidan, and the percentage was 5-10% for trees sprayed with an oil-ethion mixture. Except for the formulated mixture of oil-ethion, Sunoco's 7X oil was used in all cases.

No physical incompatibility in the spray tank was noted with any of the pesticide mixtures.

SUMMARY

Field tests for control of *Dysaphis plantaginea* (Passerini) were conducted on apples from 1964 through 1968. Excellent control was obtained when carbophenothion, ethion, Imidan, phosphamidon, or benzene hexachloride were added to superior oil and applied in the half-inch green stage of apple bud development. Superior oil 70-sec. used alone at a pre-bloom stage was very effective in some tests, but was not consistent.

All organophosphate insecticides applied at the pink stage of apple bud development gave significant control. Early post-bloom sprays of carbofuran and phosalone offered some potential in controlling the rosy apple aphid.

Significant phytotoxicity occurred after use of superior oil at the half-inch green stage in 1967 when it was applied prior to cold nights.

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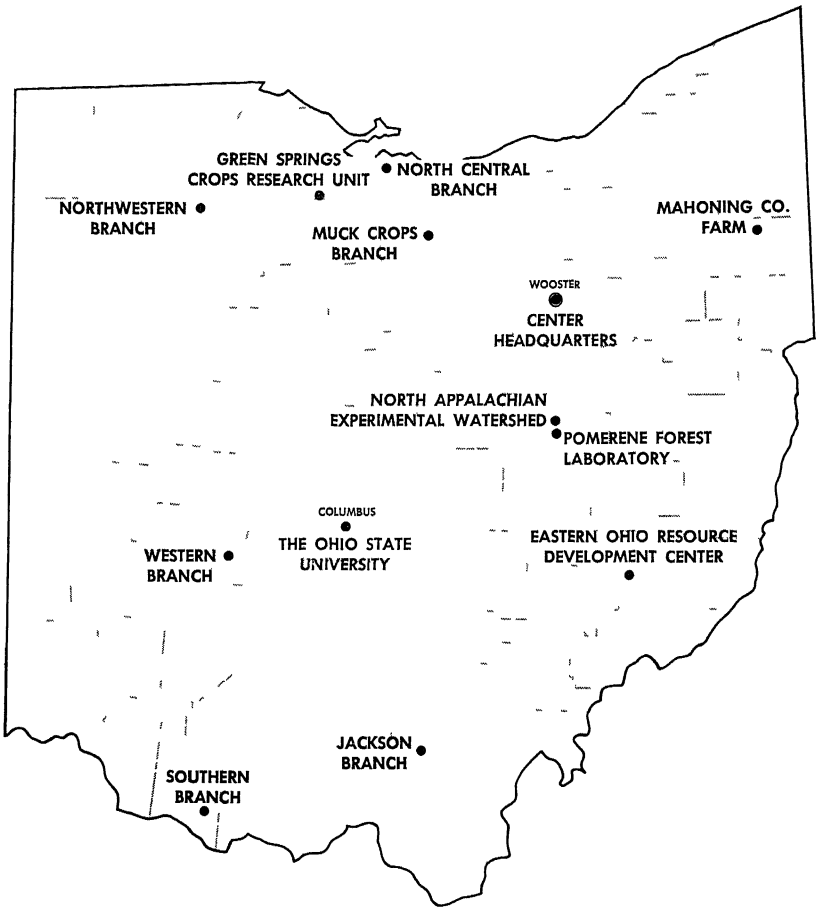

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